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oughly practical plan, but enough was done by the Legislature during the few years following to secure the chartering, in 1862 and the inauguration in 1865 of the Massachusetts Institute of Technology of which Professor Rogers became the first president, devoting to it all the energy and enthusiasm of his impulsive nature and all the varied wealth of his accomplishments and acquirements. For the rest of his life this was chosen work.*

Rogers lived to transfer to a worthy successor the completed edifice—well established and equipped—an enduring monument to the nobility of character and the consecration of talents. Honored and loved by his associates and students, he came to be recognized as “founder and father perpetual, by a patent indefeasible.” †

Of all the delightful memories of the Boston meeting in 1880 the meeting with Rogers is my pleasantest recollection. He was the central figure, losing no opportunity to make that meeting the greatest one in the history of our association. Never shall I forget when he rose

Tall in stature, with a figure of the type known to us through the pictures of Henry Clay; with a face destitute of all assumption or arrogance, was singularly commanding; with a voice whose compass and quality were capable of producing at once the largest and the finest effects of speech. ‡

and bade the Association welcome. He said:

I thank my friends for the patience with which they have listened to one who does not like to call himself an old man, but who feels something of the spirit of the war-worn soldier, who likes at times to shoulder his crutch and fight his battles over again.§

Two years later, at the same place, he rose to address the graduating class of the Institute.

* Biographical Memoirs, p. 11.

† Cooke's Notice of Rogers, p. 427.

‡ Biographical Memoirs, by Walker, p. 5.

§ Proceedings, American Association for the Advancement of Science, Vol. XXIX., 1880, p. 739.

His voice was at first weak and faltering but, as was his wont, he gathered inspiration from his theme, and for the moment his voice rang out in its full volume and in those well-remembered, most thrilling tones; then, of a sudden, there was silence in the midst of speech; that stately figure suddenly drooped; the fire died out of that eye, ever so quick to kindle at noble thoughts, and, before one of his attentive listeners had time to suspect the cause, he fell to the platform—instantly dead. All his life he had borne himself most faithfully and heroically, and he died as so good a knight would surely have wished, in harness, at his post; and in the very part and act of public duty.*

At the Buffalo meeting, in 1876, Simon Newcomb, ‘one of the most celebrated astronomers of our time,’ was chosen to preside over the Nashville meeting. Newcomb still lives and is our senior past president. He marks the dividing line between our earlier and later presidents. †

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THE SENSE OF HEARING IN ANTS.

FOR many years it has been the generally accepted opinion of naturalists that ants do not possess a sense of hearing, at least within the range of sounds perceptible to the human ear. This opinion has been based upon the failure of the experiments along this line to show any effect whatever of the loudest and shrillest noises upon the ants with which they have been tried. Foremost among the scientists who have investigated this subject may be mentioned Lubbock, Huber and Forel, whose results have all been negative.

I am not prepared to explain why the results heretofore obtained have been so decidedly negative, while those described in this article are so decidedly affirmative, unless it may be that these particular species have never been experimented upon

* Biographical Memoirs, by Walker, p. 13.

† Nature, Vol. LX., p. 1, May 4, 1899.

before. The results of these experiments can merely be stated, and the conclusions to be drawn from them left to the mind of the reader.

Only four species of ants were concerned in the experiments: *Lasius americanus* and *Formica nitidiventris*, both belonging to the family FORMICIDÆ, and *Cremastogaster lineolata* and a species of the genus *Aphaenogaster*, belonging to the MYRMICIDÆ. From the affirmative results obtained from these four species, even if they were absolutely certain, we could not, of course, draw any certain affirmative conclusions as to the whole group of ants; but even these few results are at least a favorable indication.

The experiments were performed both upon individuals and upon whole colonies. As there were about eighty experiments recorded for the four species, I can describe only a few of them and make general statements as to the others. The following are extracts from my notebook, and are significant in themselves.

Cremastogaster lineolata.

(1) May 2, 1899, 10:45 a. m. Ant wandering about isolated. I struck a steel sounding-bar of vibration-number 4096 (complete vibrations). Ant immediately raised its head and waved the antennæ.

(2) 10:56. Ant moving left front leg. Blew several blasts on a small bottle, being very careful not to blow upon the ant. Ant drew back the antennæ and began waving them immediately.

(3) 11:00. Same conditions. Struck the sounding-bar as in (1). Ant turned head and antennæ *toward the bar*, waving the antennæ slightly.

Another individual, same species.

(4) May 2, 5:05 p. m. Ant perfectly quiet. Blew short blasts on a small bottle, as in (2). Ant raised its head and waved the antennæ.

(5) 5:09. Same conditions. Blew a long,

steady blast on a shrill wooden whistle. Ant began waving antennæ violently and kicking with one leg.

(6) 5:25. Ant walking along slowly on a strip of paper. Blew a shrill blast on a tin whistle. Ant started forward suddenly and walked faster.

(7) 5:29. Ant quiet. Blew a long blast on the shrill wooden whistle. Ant turned nearly half way around *toward the whistle*, waving the antennæ.

(8) 5:31. Ant quiet. Blew a short blast on the wooden whistle. Ant raised the antennæ high in the air and moved the abdomen up and down several times.

(9) 5:32. Ant quiet, facing me. Same experiment. Ant started *backward* suddenly and then began waving the antennæ.

Another individual, same species.

(10) May 4, 10:18 a. m. Ant quiet. Struck a tuning-fork (key middle A) and touched it several times to a piece of cardboard suspended in the air about two inches above the ant, making clear sounds. Ant raised the antennæ slightly at each sound.

Lasius americanus.

(11) May 8, 11:08 a. m. Ant walking along on a piece of paper. Touched a tuning-fork, as in (10), to a card a little in front of the ant. Ant immediately turned around and walked *in the opposite direction*.

Another individual, same species.

(12) May 11, 10:48 a. m. Ant wandering about isolated. Touched a card several times to a rapidly rotating milled disk near the ant, producing loud sounds. Ant walked more slowly, apparently crouching down, but occasionally starting forward as the sounds became more piercing.

Aphaenogaster sp.

(13) May 19, 3:18 p. m. Ant perfectly quiet, confined by loose cotton in a test-tube. Suspended the tube in the air near the steel sounding-bar mentioned in (1) and struck the bar several times. Ant first

moved the antennæ, then the head, then the thorax, to and fro, and finally began to walk.

Formica nitidiventris.

(14) May 19, 4:08 p. m. Ant quiet, and confined in a test-tube as described in (13). Suspended the tube in the air near the rotating milled disk (12). At each sound from this apparatus the ant showed unmistakable signs of agitation, quickly moving the head and antennæ.

In addition to these, I may also mention an experiment tried on the colony as a whole with each of these species except *Formica nitidiventris*, with which I had no opportunity to try it. The colony being quiet in their nest under a plate of glass, I produced with the lips or with an instrument clear, shrill notes, taking the greatest care not to blow upon the nest or to allow anything else but the sound to disturb the colony. The ants instantly showed, by their quick movements in all directions, unmistakable signs of excitement or alarm. I tried this over and over again with each of the three species, in the presence of visitors to the laboratory, and the result was invariably the same. All who saw it admitted at once that their doubts as to the sense of hearing in those ants were entirely removed.

As to the remainder of the experiments, lack of space prevents me from describing them, but let it suffice to say that by far the greater part of them gave results just such as those already described.

The persistence of these affirmative results led me to a conclusion which is embodied in the statement of the following thesis: *The ants, or at least some of the ants, are capable of perceiving vibrations, conducted through the air or other media, which are audible as sound to the human ear.* It will be noticed that I do not assert that any of the ants hear, in the ordinary sense of the word; neither do I deny it; my statement is

merely that some of them are capable of *perceiving* ordinary sound vibrations, which does not necessarily imply a true sense of hearing. However, in all the experiments, great care was taken in various ways to prevent the vibrations from reaching the ants through solids as media. And if it be true that this sensation, apparently due to a sense of hearing, is merely that of a mechanical vibration or jarring produced by the sound waves (and hence would pertain in a measure to the sense of touch), how shall we explain the results of experiments like (3), (7), (9) and (11), which certainly indicate a sense of direction? And how shall we account for the fact, shown in many of my experiments, that some ants which pay little attention to being knocked and jarred about in their glass prisons are driven nearly frantic, apparently, by shrill sounds? The result of experiment (8) should also be noted as of special importance. For this ant (*Cremastogaster lineolata*) is a stridulating species, and the movement of the abdomen mentioned is one of stridulation, producing a minute sound; the significance of this fact is obvious, indicating a response on the part of the ant to the sound of the whistle.

I might proceed to discuss at length the results of these experiments, arguing from standpoints based on the principles of psychology; but for the present it will be necessary, as before stated, to leave the experiments with their results as described to the consideration of the reader, and permit him to deduce his own conclusions.

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ARE THE TREES ADVANCING OR RETREATING UPON THE NEBRASKA PLAINS? *

Two years ago I presented a paper before this Section showing that there are reasons

* Read before Section G, Botany, of the American Association for the Advancement of Science, August, 1899.